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IS 8883-2-3 (1978): Methods of sampling chemicals and chemical products, Part 2: Sampling equipment, Section 3: For gases [CHD 1: Inorganic Chemicals]



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IS : 8883 ( Part II/Sec 3 ) - 1978

*Indian Standard*  
METHODS OF SAMPLING  
CHEMICAL AND CHEMICAL PRODUCTS  
PART II SAMPLING EQUIPMENT  
Section 3 For Gases

UDC 543.053 : 543.271



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INDIAN STANDARDS INSTITUTION  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

Gr 6

Price Rs. 10.00

July 1979

# *Indian Standard*

## METHODS OF SAMPLING CHEMICAL AND CHEMICAL PRODUCTS

### PART II SAMPLING EQUIPMENT

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*Indian Standard*  
**METHODS OF SAMPLING  
CHEMICAL AND CHEMICAL PRODUCTS**

**PART II SAMPLING EQUIPMENT**

**Section 3 For Gases**

**0. FOREWORD**

**0.1** This Indian Standard ( Part II/Sec 3 ) was adopted by the Indian Standards Institution on 5 May 1978, after the draft finalized by the Chemical Standards Sectional Committee had been approved by the Chemical Division Council.

**0.2** It may be emphasized that the most careful work in the laboratory or quantitative results may be rendered useless if care is not taken when drawing the sample. The sample has to be truly representative of the lot, should not include material other than that to be sampled and should not change in composition before testing.

**0.3** Equipment commonly used for sampling of chemicals and chemical products in the form of gases are covered in this section. This section does not cover statistical aspects of sampling like scale of sampling, number of tests, criteria for conformity or preparation of test samples. The general requirements and precautions in sampling of chemicals and chemical products have been covered in Part I of this standard.

**0.4** In the preparation of this standard assistance has been derived from the following:

ISO/TC 47/WG 15/TG 2 ( United Kingdom-7 ) 19 Sampling of gaseous chemical products. International Organization for Standardization.

Doc: 70/11092 Draft British Standard Methods of sampling chemical products, Part II. Sampling of gases. British Standards Institution.

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**1. SCOPE**

**1.1** This standard ( Part II/Sec 3 ) deals with common sampling equipment for chemicals and chemical products in the form of gases. It also describes the procedure to be followed in using those equipment.

## **2. GENERAL PRECAUTIONS AND REQUIREMENTS**

**2.1** It is not possible to give general directions regarding sampling equipment explicit enough to cover all cases. The guidelines given in this standard should be supplemented by judgement, skill and sampling experience. It should be ensured that the samples drawn should represent the general character and average condition of the material.

**2.2** The type of sampling equipment should be chosen depending upon:

- a) type of sample;
- b) size and type of container ( pipeline, etc );
- c) amount of sample required for tests;
- d) whether sample is in homogeneous or heterogeneous form;
- e) reactivity of sample with material of construction of sampling equipment;
- f) whether a spot sample or continuous or intermittent sample ( from a pipeline ) is required;
- g) whether surface or middle or bottom sample is required; and
- h) whether sampling is to be done hot, cold or at room temperature.

**2.3** The whole sampling apparatus, including equipment, cords, connecting tubing and sample containers should be free from any contaminating substance. The sample container should be tightly closed immediately after sampling.

**2.4** The operator engaged in sampling should have clean hands. In certain cases it may be essential for the operator to wear gloves to safeguard against health or other hazards. In special cases the operator may also use goggles or gas mask. Liquefied gases cause cold burns and thus should be prevented from coming into contact with skin.

**2.5** Whenever possible the sampling equipment and the sample container should be purged thoroughly when a gas is to be sampled.

**2.6** To avoid mixing up of samples collected at a time, the sample containers should be labelled and clearly marked before transferring the sample. It is preferable to use separate sampling apparatus for separate samples. In marking the container, name of sample, number, date of sampling, supplier's name, batch number and other relevant details should be mentioned.

**2.7** All metal components of sampling equipment, used in a flammable atmosphere should be constructed of non-ferrous metal ( to avoid sparks ).

**2.8** Discharge of liquefied petroleum gas can give rise to static electricity and it is essential to connect the metallic bombs/cylinders to 'earth' during discharge.

**2.9** Samples of materials which may be affected by light or heat should be stored in a cool and dark place. Periodical examination of containers should be made for leakage.

**2.10** Sampling equipment, connecting tubing and sample container should be constructed of a material unreactive to the material to be sampled. Various materials of construction can be:

- a) glass ( heat resistant/borosilicate );
- b) steel/stainless steel (O4Cr17Ni12Mo2, or alloy steel/plain steel, cast iron/wrought iron );
- c) non-ferrous ( brass, copper, lead, aluminium );
- d) plastics [nylon, polyvinyl chloride ( PVC ), acrylonitrile butadiene styrene ( ABS ), polyethylene]; or
- e) rubber ( neoprene, nitrile, synthetic ).

**2.11** Sampling equipment should be checked periodically in order to ensure its safety and safety of the operator.

### **3. SAMPLING EQUIPMENT FOR GASES**

**3.1 General** — A gaseous chemical product may be contained in cylinders, gas holders or pipelines. Because a gaseous mixture confined within a container tends to become homogeneous by diffusion, and a flowing gas stream can usually be mixed by inducing turbulence, any variability of composition is normally temporary and it is possible to obtain a representative sample. Emphasis is, however, laid on collection of a sample free from contamination. Sampling is related to time and flow rate of gas rather than to a finite volume of gas. Besides the above factors choice of sampling equipment also depends on volume of gas required for testing which may range from a fraction of millilitre for a mass spectrometer analysis up to 20 litres for a sulphur determination by combustion method. The sampling equipment for liquefied gases have been discussed in Part II, Section 2 of this standard. The basic parts of any sampling system are the sampling probe, the sample container line, the sample container (tube) and the aspirator or exhauster. Auxiliary parts which may be needed include filters, traps, seals, pressure regulators and safety valves.

#### **3.2 Classification of Methods**

**3.2.1** The methods for sampling gases can be classified as follows:

- a) High pressure bomb method,
- b) Confining liquid displacement method,
- c) Vacuum displacement method, and
- d) Bladder method.

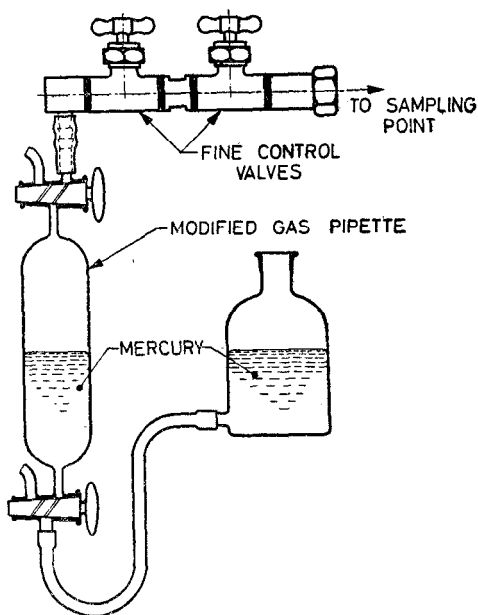
**IS : 8883 ( Part II/Sec 3 ) - 1978**

**3.2.2** Another classification of methods of sampling can be done on the basis of gas pressure that is:

- a) Gas at high pressure,
- b) Gas at slightly above atmospheric pressure, and
- c) Gas at or below atmospheric pressure.

**3.3 Sampling Equipment Used in High Pressure Bomb Method —**

This method is applicable to liquefied gases where the sample is collected in liquid form and testing may also be done on liquid sample itself. Alternatively, the liquefied gas sample can be converted into gaseous phase and the gas collected in a vaporizing equipment (see Fig. 1) say, gas pipette or aspirator bottle. The capacity of the gas pipette or aspirator should be large enough to contain all the vaporized sample at substantially atmospheric pressure.



**FIG. 1 GAS SAMPLING BOMB WITH VAPORIZING EQUIPMENT**

**3.3.1 Procedure for Collection of Gaseous Phase Sample Using Gas Sampling Bombs —** For details of design and construction of certain types of gas

sampling bombs refer to **3.7.1.1(a)** ( 1 litre capacity ), **3.7.1.3(a)** ( 2 ml capacity ) and **3.7.2.1(a)** ( 4 litre capacity ) of IS : 8883 ( Part II/Sec 2 )-1978\*. Special bombs up to 25 litre capacity can be used for sampling gases. Connect the inlet valve of the bomb to the sample source valve. If the source pressure exceeds the working pressure of the bomb, instal a single stage reducing valve between source and bomb. Open both outlet and inlet valves and connect the outlet valve by means of a non-reactive tubing to a gas meter when sampling, ensuring safe disposal of gaseous vapours. Open the sample source valve and pass the gas through the bomb about 15 times the volume of bomb as indicated by gas meter. Close the valves in this order-outlet, inlet and sample source. The gas sample is now at source pressure or if a reducing valve was used, at the outlet pressure of the valve. Disconnect the bomb from the sample source and mark for testing.

### **3.4 Sampling Equipment Used in 'Confining Liquid Displacement'**

**Method** — This is applicable where it is unsafe to vent the gas sample in the atmosphere or when limited sample is available or the source pressure is low. The sample container is filled with the confining liquid, which is then displaced by the sample. The confining liquid may be distilled water but for some gases which have high solubility in water ( for example, carbon dioxide, hydrogen sulphide and olefins ), concentrated salt solution can be used. A 30 percent sodium chloride solution slightly acidified with dilute hydrochloric acid is commonly used as the confining liquid in sampling water-soluble gases. Confining solutions should be pre-saturated with the gas to be sampled. To overcome solubility errors, mercury is best used as the confining liquid when taking small samples. However, mercury also reacts with hydrogen sulphide in presence of moisture. The sample containers used for the purpose of sampling include gas pipette and aspirator.

#### **3.4.1 Gas Pipette ( Also Known as Gas Tube or Sampling Tube )**

**3.4.1.1 Design and construction** — Figure 2 shows two gas pipettes, Type A ( see Fig. 2A ) straight stopcock and Type B ( see Fig. 2B ) with double oblique bore stopcock. The pipettes are cylindrical, borosilicate vessels with hemispherical or conical ends, fitted with well ground stopcocks at both ends. The stopcocks should be lubricated with a non-hydrocarbon and non-absorbing lubricant such as starch mannitol glycerine paste ( this paste is prepared by mixing thoroughly 30 parts of dextrin, 7 parts of mannitol and 50 parts of glycerine until a thick paste is obtained. The paste is heated until it just begins to boil, after which it is allowed to cool with occasional stirring ). Suitable nominal capacities of this type of

\*Methods of sampling chemical and chemical products: Part II Sampling equipment, Section 2 For liquids.

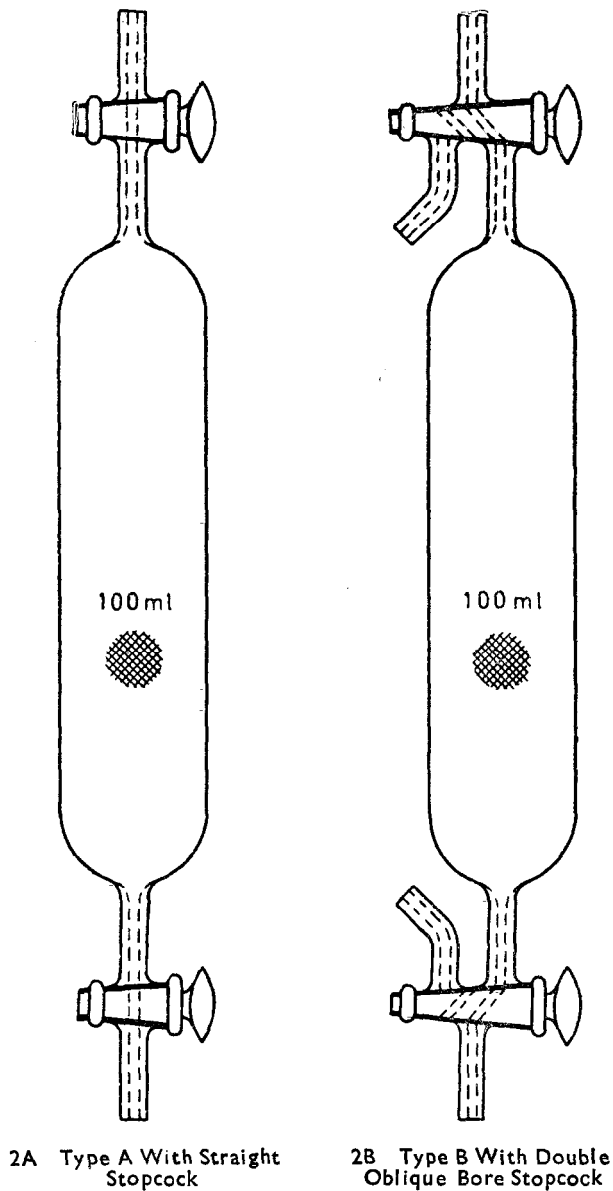


FIG. 2 GAS PIPETTE

sample vessel are 100 ml and 250 ml. The connecting tubing should be of glass joined together with tubing of neoprene nitrile rubber or nylon using butt joints. Natural rubber tubing and synthetic rubber or plastic tubing may absorb certain gases.

**3.4.1.2 Procedure (for using gas pipette)** — Place the pipette in a vertical position and completely fill it with the confining liquid from a levelling bottle or aspirator bottle, connected to the lower stopcock. Connect the upper stopcock to the sample source and with the stopcock in the position open to atmosphere. Purge the line by opening the sample source valve. Now turn the upper stopcock to direct the flow of the gas into the gas pipette and displace the confining liquid by suitable adjustment of the source valve and levelling bottle valve. During this operation, the liquid in the gas pipette and levelling bottle should be maintained at nearly the same level.

### 3.4.2 Aspirator Bottle ( Mariotte Bottle )

**3.4.2.1 Design and construction** — A typical design of aspirator is shown in Fig. 3. It is usually made of glass ( or polyethylene ) and employs the Mariotte bottle principle to maintain a constant liquid head. A glass delivery tube bent at 90° is fitted into the cork on the neck of aspirator bottle. The outer end of the tube may also be provided with a stopcock.

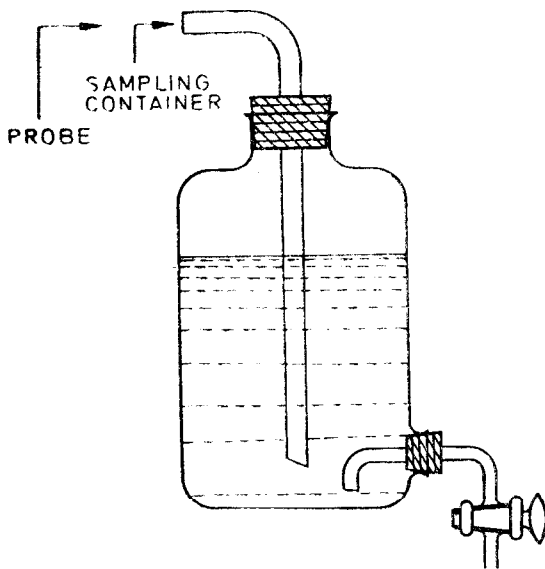


FIG. 3 ASPIRATOR ( MARIOTTE ) BOTTLE

**3.4.2.2 Procedure for using aspirator** — Place the aspirator bottle in a vertical position and completely fill it with confining liquid. Connect the upper end of the delivery tube to the source valve. Without placing the cork on the bottle, pass the gas sample to purge the line and to saturate the confining liquid. Close the source valve and place the cork on the aspirator bottle. Open the cock connected to the bottom of aspirator bottle and also the source valve controlling the flow of gas carefully. The gas sample replaces the confining liquid in the bottle and when the liquid stops flowing out of the bottle, close the source valve and then the cock of the aspirator bottle. Disconnect the bottle from the source valve and plug the free end of the delivery tube. In case a cock is connected to the delivery tube, the order of closing the cock/valve should be first source valve, then inlet cock and finally the outlet cock.

### **3.4.3 Gas Pipette — Aspirator Assembly**

**3.4.3.1 Design and construction** — Figure 4 shows the gas pipette-aspirator assembly. This is applicable to sampling of gas which is at atmospheric pressure or slightly below that. Two aspirators are used in series with a gas pipette.

**3.4.3.2 Procedure for using gas pipette — aspirator assembly** — Completely fill the pipette and the aspirator connected to it, with confining liquid from the second aspirator by suitable manipulation (raising it above). Connect the pipette to the sample source and purge the line. Then turn the upper stopcock on the pipette in such a way so as to collect the gas sample. Collect enough gas to fill the pipette and part of the aspirator connected to it. During this operation, slowly lower the second aspirator to maintain the pressure in the gas pipette and its associated aspirator, approximately atmospheric. Close the upper stopcock on the pipette and the source valve, and disconnect from the source. Raise the second aspirator so that gas is forced into the sample pipette until the pressure is slightly above that of atmosphere. Close the lower stopcock on the pipette, then close the stopcocks on the aspirators and disconnect the pipette.

**3.5 Sampling Equipment Used in Vacuum Displacement Method** — This method is preferred to confining liquid displacement method for sampling gases containing hydrogen sulphide and other water-soluble constituents, such as carbon dioxide and olefins. A metal bomb [ see 3.7 of IS : 8883 ( Part II/Sec 2 )-1978\* ], gas pipette ( see 3.4.1 ) or aspirator ( see 3.4.2 ) are suitable for collecting gases at atmospheric pressure. If an aspirator is used, it should be made of borosilicate glass and completely encased in a protective gauze or other suitable housing. Connecting tubing is of same type as discussed under 3.4.1.1.

\*Methods of sampling chemical and chemical products: Part II Sampling equipment, Section 2 For liquids.

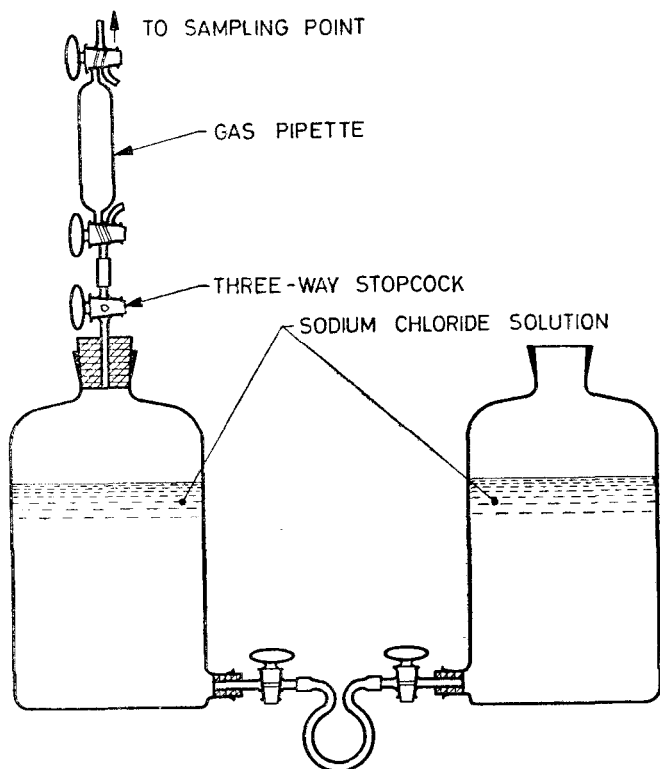


FIG. 4 GAS PIPETTE ASPIRATOR ASSEMBLY

**3.5.1 Procedure** — Connect one end of the sampling apparatus to the sample source valve and the other end to a manometer and suction pump. Use a T-piece if the sampling apparatus has only one valve. Evacuate the sampling apparatus and connecting lines to a pressure of 1 mm of mercury or less. Shut off vacuum and check that the system is leak-proof. Open the sample source valve and admit sample into the sampling apparatus until atmospheric pressure is obtained. Close the source valve. Re-evacuate the sampling apparatus and lines and repeat the above operation. This step ensures purging of sampling apparatus and lines. The final pressure in the sampling equipment, if possible, should be slightly greater than that of the atmosphere. Close the stopcocks or the valves of the sampling apparatus and disconnect it from the source.

**3.6 Sampling Equipment Used in Bladder Method** — This method is suitable for the collection of small samples of gases at slightly above atmospheric pressure, provided the sample is not to be transported to a long

distance, nor stored for long time. Though this method does not provide the highest degree of accuracy but for certain applications it is more convenient than the other methods described.

**3.6.1 Design and Construction of Bladder**—It is of flexible non-porous material, not affected by the gases for which it is used. Rubber ( neoprene or nitrile ) football bladders are quite suitable for certain applications. Connecting tubing should also be made of the same type of rubber or nylon. The bladder may be fitted with single or double tubes closed by screw clips ( or stopcocks ). Even synthetic rubber, polyester and other plastic materials can be used for making bladders.

### **3.6.2 Procedure for Using Bladder**

**3.6.2.1 Single tube bladder** — Open the sample source valve, purge the line thoroughly with the gas and adjust the valve to inflate the bladder at a suitable rate ( slow ). The tube of the bladder is connected to the source valve and the bladder inflated to its normal size ( avoiding excessive increase in pressure of gas inside the bladder ). Disconnect the bladder and deflate it. Expel as much gas as possible by rolling up the bladder on a flat surface. Repeat three times to purge the bladder thoroughly. Finally, inflate the bladder to normal size, close the sample source valve, seal the bladder with a screw clip or stopcock, and disconnect the bladder.

**3.6.2.2 Double tube bladder**— Attach the bladder, with its inlet and outlet tubes open, to the sample source. Open the sample source valve and purge the bladder thoroughly. Close the screw-clip ( stopcock ) on the outlet tube to inflate the bladder, close the sample source valve, then the screw clip or stopcock on the inlet tube, and disconnect the bladder.

## **3.7 Miscellaneous Sampling Equipment for Gases**

### **3.7.1 Rubber Bulb Aspirator**

**3.7.1.1 Design and Construction** — A typical design of a 125 ml capacity rubber bulb aspirator is shown in Fig. 5. This is a hand operated bulb normally used for sampling of small quantity of toxic gases. The bulb is fitted with inlet and outlet valves. It is valuable in field work. The limitations of the equipment are its low exhaustive power, small capacity and deterioration of the rubber bulb in contact with some vapours. The metallic connections are made of stainless steel and the connecting lines of resistant rubber ( neoprene ) or nylon.

**3.7.1.2 Procedure for using rubber bulb aspirator** — Exhaust the air in the bulb by compressing it, the inlet valve having been closed. Open the sample source valve and inflate the bulb slowly to its normal size. Re-exhaust the contents of the bulb by closing the inlet valve and pressing the

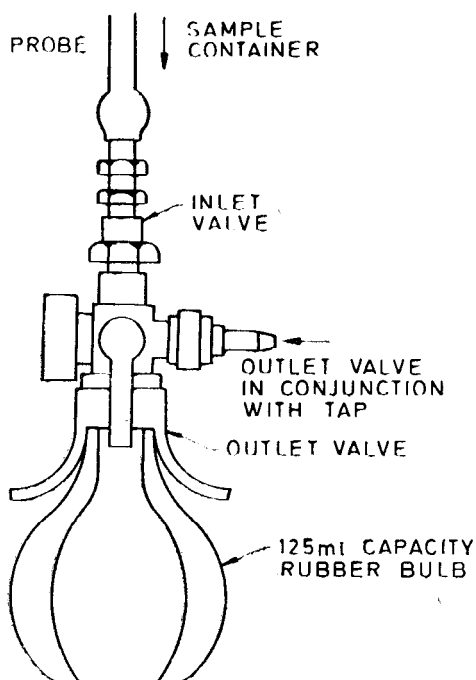


FIG. 5 RUBBER BULB ASPIRATOR

bulb. Again open the source valve and inflate the bulb to its normal size. Repeat the process 3 or 4 times for thorough purging of the bulb. Finally, inflate the bulb with the gas sample, close the source valve and disconnect the equipment from the source.

**3.7.2 Evacuated Glass Vessels** — These are often used for sampling air and atmospheric gases.

**3.7.2.1 Gas ampoule** — A glass ampoule of adequate strength is evacuated below 1 mm mercury pressure before the neck is sealed and drawn out to a fine point. When required for use, the drawn out end is scratched and broken and the ampoule allowed to fill with the atmospheric gas. The open end is then sealed by means of sealing wax or a plastic tube closed at the end. This should not be stored for long. Low capacity is another disadvantage with the ampoule.

**3.7.2.2 Vacuum bottle** — A typical vacuum bottle is shown in Fig. 6. It is made of strong thick walled glass. The bottle is evacuated via stopcock A which is then closed, the pressure within the bottle being

observed on a manometer attached to *B*. After evacuation, the gas is introduced through the bottle by opening stopcock *A*, connected to sample source. When equilibrium is reached as indicated by manometer, close cock *A* and then close source valve. Disconnect the bottle from the sample source. The volume of gas collected can be easily calculated from the rise in pressure (equilibrium pressure minus evacuated pressure), the temperature (a thermometer is provided for this purpose) and capacity of the bottle.

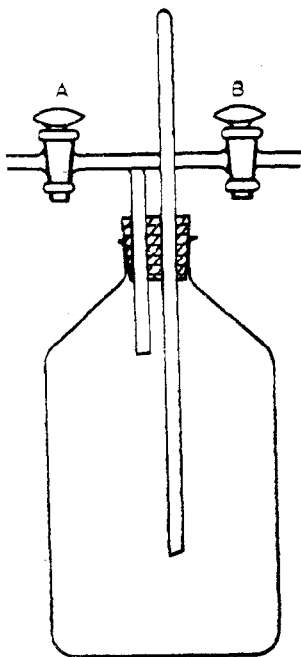


FIG. 6 VACUUM BOTTLE

**3.7.2.3 Glass flask (container)** — Figure 7 shows a borosilicate glass flask fitted with standard taper stopper. It is suitable for vacuum sampling. The flask is evacuated by applying suction through 3 mm vacuum tap (3-way). Connect the tube fitted with a stopcock to the sample source valve. Open the stopcock and then the source valve. Connect the vacuum line if required. The gas sample passes into the flask and after sufficient purging (about 15 times the volume of gas in comparison to volume of flask) is over, connect the three way tap to the atmosphere. Close the source valve and then the stopcock, three way tap being disconnected from the atmosphere or vacuum line.

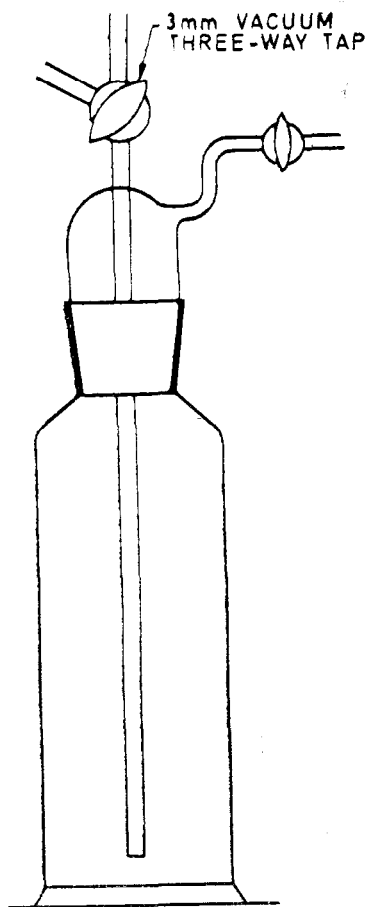


FIG. 7 GLASS FLASK

**3.7.3 Small Metal Cylinder** — Metal cylinders (or bombs) are essential for sampling of gases at high pressure and are convenient when it is necessary to collect a large volume of gas. The cylinders made of stainless steel (or special steels) and fitted with needle valves at both ends, are in capacities ranging from 100 ml to 2.5 litres. Such cylinders are made to withstand  $28 \text{ MN/m}^2$  pressure and should be tested to the maximum permitted pressure at regular intervals.

### **3.8 Sampling Equipment for Gas at High Pressure**

**3.3.1** For moderate pressure ( up to  $6.6 \text{ kN/m}^2$  ) insert a T-piece between the sampling line and the gas pipette ( *see* Fig. 2 ) or gas sampling tube and connect one limb of the T-piece to a suitable safety valve, for example, an adequate seal of mercury, oil or water. Connect the clean dry sampling tube to the sampling line, open the tap ( outlet valve, inlet valve and then the source valve ) and allow gas equivalent to at least 10 times the volume of the sampling line and tube to flow through so that the tube is thoroughly purged. Close first the outlet tap, then the inlet tap and remove the sampling tube. If the gas sample is hot, the sample should be collected under pressure to an extent that on cooling to ambient temperature, the gas will not be appreciably below atmospheric pressure. This precaution minimizes the risk of subsequent air leakage into the sample. If the gas sampled is toxic or flammable, vent the excess gas to a safe location. For gases at high pressures a stainless steel metal bomb equipped with two steel needle valves (for example, 6 mm) and tested to twice the working pressure to which it may be subjected [ *see* Fig. 12 of IS : 8883 ( Part II/Sec 2 )-1978\* for 1 litre capacity bomb ] can be used. As regards diameter, length and capacity of various sizes of bombs up to 1 litre capacity refer to Table under **3.7.1.1(a)** of IS : 8883 ( Part II/Sec 2 )-1978\*. Connecting tubing of sufficient strength to withstand the operating pressure of the system should be used together with fitted unions. Iron pipe may be used in the absence of hydrogen sulphide or other gases which react with iron. Sample bombs should be inspected at frequent intervals and tested at least every 12 months. Such testing should include steaming, hydrostatic pressure tests and inspection of valve seats and packing. Each bomb should be marked with testing data, maximum working pressure and tare weight. For details of method refer to **3.3.1**.

**3.3.2** Steel cylinder is also suitable for gas filling. Such cylinders are tested up to twice the working pressure before use. Connect the sampling line to a steel cylinder, open the cylinder valve and the source valve. Purge the cylinder by filling the gas and then releasing the same. Fill the gas and close the valves and remove the sample cylinder from the sample source. Inclusion of a suitable bursting disc on the filling line is a desirable precaution. The sampling cylinder is attached to the line and allowed to refill after a preliminary filling and bleeding. The cylinder shall be fitted with a pressure regulator and gauge and a bleed valve. The cylinder may be cleaned by repeated purges. Purging should be done by filling to a suitable pressure ( say  $350 \text{ MN/m}^2$  ) and bleeding to slightly above atmospheric pressure. Before collecting a sample purge the sample line with the gas. Close the source valve, attach the cylinder and re-open the valve, filling the cylinder to the required pressure. Bleed gas from the

\*Methods of sampling of chemical and chemical products: Part II Sampling equipment, Section 2 For liquids.

cylinder to reduce pressure to slightly above atmosphere. Refill and bleed again, then finally refill to the desired pressure. Close the source valve and the cylinder valve. Remove the cylinder from the source.

**3.9 Sampling Equipment for Gases at a Pressure Slightly Above Atmospheric Pressure**—For sampling of gases at slightly above atmospheric pressure, the gas pipette ( *see* Fig. 2 ) can be used. The procedure is the same as described under 'sampling of gases at high pressure' ( *see* 3.8 ) except that T-tube is not required. Alternatively, bladder ( *see* 3.6 ) can be used.

**3.10 Sampling Equipment for Gases at or below Atmospheric Pressure**—Gas pipette ( *see* Fig. 2 ) can be used for sampling of a gas at or below atmospheric pressure, but the help of vacuum line is normally necessary. Connect one end of a gas pipette to the sampling line and the other end to an aspirator, a large evacuated receiver or a vacuum pump. Withdraw sufficient gas to purge adequately the sampling line and gas pipette, close first the outlet, then the inlet valve ( tap ) and then remove the gas pipette. The gas pipette itself may be evacuated before use ( *see* 3.4.1 ). In such a case after purging the sampling line, with the inlet valve of the pipette connected to atmosphere, admit gas into the evacuated pipette. When sample is collected, again connect the inlet valve to atmosphere and remove the gas pipette from the source. It is permissible to locate the vacuum pump between the sampling point and the sampling vessel. The vacuum pump evacuates the sampling vessel ( gas pipette or metal cylinder ).

### 3.11 Sampling Equipment for Taking Continuous Gas Sample

**3.11.1** Sometimes the objective is to fill the sample container at a controlled uniform rate throughout the period of sampling. To achieve this objective, a rapid stream of gas is withdrawn through the probe, then this stream is divided by a T-piece arranged to divert a small proportion of the gas into the collecting device and to vent the remainder to waste or to return it to the main flow. This principle ( employing liquid displacement method ) is used in the apparatus shown in Fig. 8. The apparatus features a trap for condensate, a non-return valve to prevent back diffusion of the collected sample and a mercury valve to prevent excessive vacuum. In use, the calibrated collecting vessel ( gas pipette *A* ) is filled initially with mercury ( with the help of a reservoir ) and a rapid gas stream passes through the mercury bubbler to the vacuum pump ( purging step ). The sample is then drawn into *A* at the rate at which mercury drains out through the stopcock ( outlet of gas pipette *A* ) and since this depends on the head of mercury, the sampling rate will tend to decrease as time passes unless stopcock is adjusted. After collecting the sample in gas pipette *A*, it may be transferred to a smaller gas pipette *B*, in which it is stored at a pressure slightly above atmospheric. During this transfer too liquid displacement

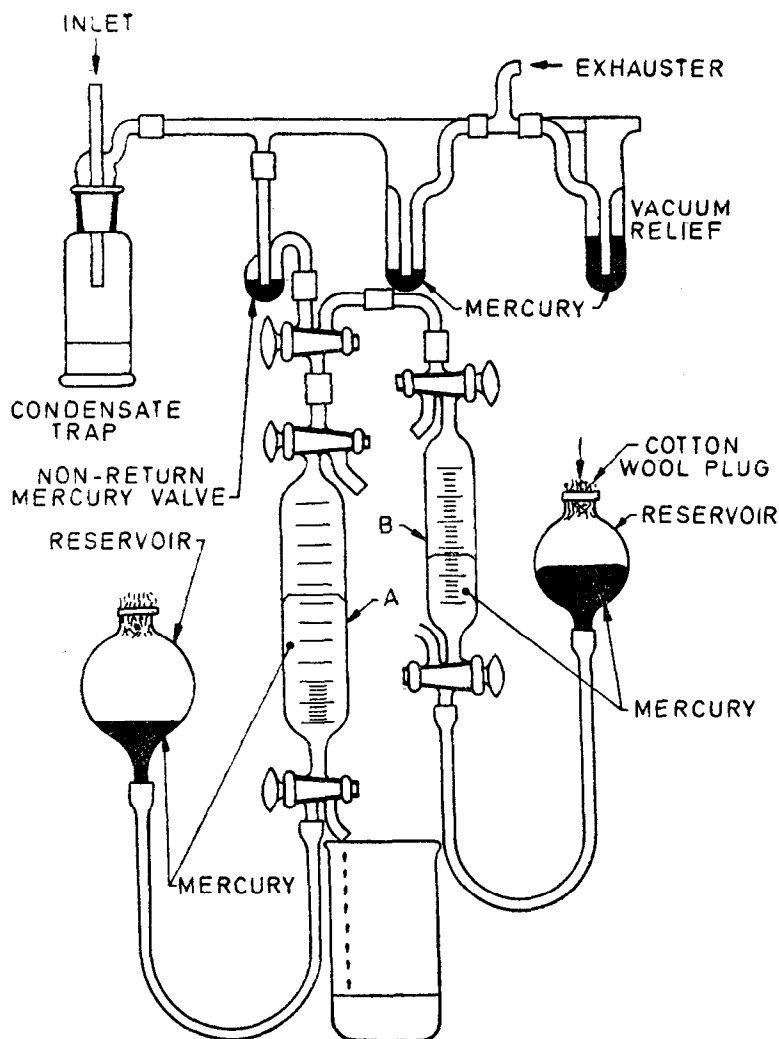


FIG. 8 EQUIPMENT FOR TAKING CONTINUOUS GAS SAMPLE

(mercury) method is used. Among the disadvantage of this type of apparatus are the need to manipulate a considerable amount of mercury and to adjust the flow rate occasionally.

**3.11.2** A modification of the continuous sampling apparatus described under 3.11.1, is shown in Fig. 9. In this method the gas pipette *A* is filled

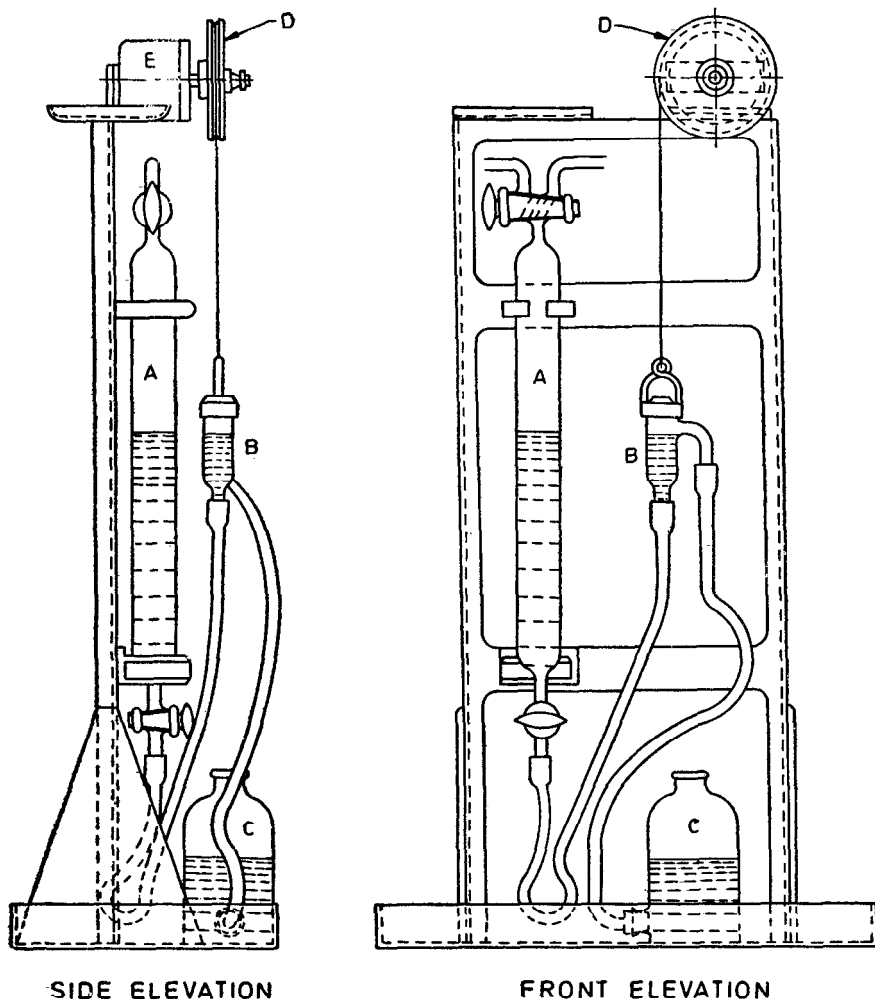


FIG. 9 MODIFIED APPARATUS FOR TAKING CONTINUOUS GAS SAMPLE

with a confining liquid (say concentrated salt solution). It is connected to the reservoir C via an overflow tube. The sampling rate is determined by the rate at which B is lowered, this being governed by the pulley D and the constant speed motor E. As explained under 3.11.1, there may be a T-tube between the sample source and the sampling apparatus so that only a limited amount of gas is fed into the apparatus, the rest being vented out.

After filling the gas pipette *A* with the confining liquid manipulating reservoir *C* ( raising it with inlet and outlet cocks open ), overflow tube *B* is positioned at the top on pulley *D*. The connecting line is then connected to the inlet cock of pipette *A*. Overflow tube *B* is lowered with the help of pulley *D* at a constant rate, the pulley being driven by a small motor ( with reduction gears for slow speed ). The sample is continuously filled in pipette *A* and when the required volume of gas is obtained, close the inlet cock of *A* and disconnect from the source. The pressure of gas sample in the pipette can be maintained at slightly above the atmospheric pressure by manipulating *B* ( raising it above with outlet cock of pipette open ).

**3.12 Apparatus for Taking Intermittent Gas Sample** — An apparatus known as Dudden's apparatus is shown in Fig. 10 for collection of an intermittent sample. A specially designed gas pipette *B* carries a tap *A* the key of which has one or more hemispherical depressions instead of the normal through drilling. As the key rotates each depression is brought into contact with the gas stream and the mercury in pipette *B* alternatively. When in contact with *B*, the depression fills with mercury; after half a revolution this mercury falls into the seal of *D* and the depression fills with gas, which is released into *B* after half a revolution. In this way, an average sample consisting of a large number of small increments can be collected over a desired time. The gas sample can be recovered at tap *C* by allowing the mercury to flow from reservoir *E* via tap *F*. The key may be rotated by an electric motor with suitable reduction gear train. The speed may be approximately adjusted at about 1 revolution per minute. For satisfactory operation, the depression in the key should be about 7 mm diameter. The edges of key should be slightly ground. The tube connecting key *A* to the bulb *B* should have internal diameter not less than 6 mm.

**3.13 Apparatus for Isokinetic Gas Sampling** — In certain processes a gas stream contains entrained ash, lime, carbon or other dust particles which are required to be estimated. The method is to weigh the dust particles which are separated by means of a filter from a measured volume of gas. This type of sampling poses certain problems because several variables are involved, namely, the size and shape of the dust, velocity and temperature of gas and the particle size of the dust. Further complications arise if water or tar is present in the gas to be sampled. In such cases it is essential to sample the gas under isokinetic conditions, that is, the probe faces the source of the gas and gas enters the probe at the same linear velocity and from the same direction as the main gas stream. Figure 11 gives a block diagram of isokinetic sampling equipment. The sample collector is usually a filter of known weight, but a cyclone may be used to collect the larger particles from a heavily laden gas stream, backed by a filter to collect the fine particles. If the gas sample is wet, the filter shall be heated above the dew-point.

The cooling coil serves to condense corrosive vapours and to bring the gas to a convenient and uniform temperature before passing through



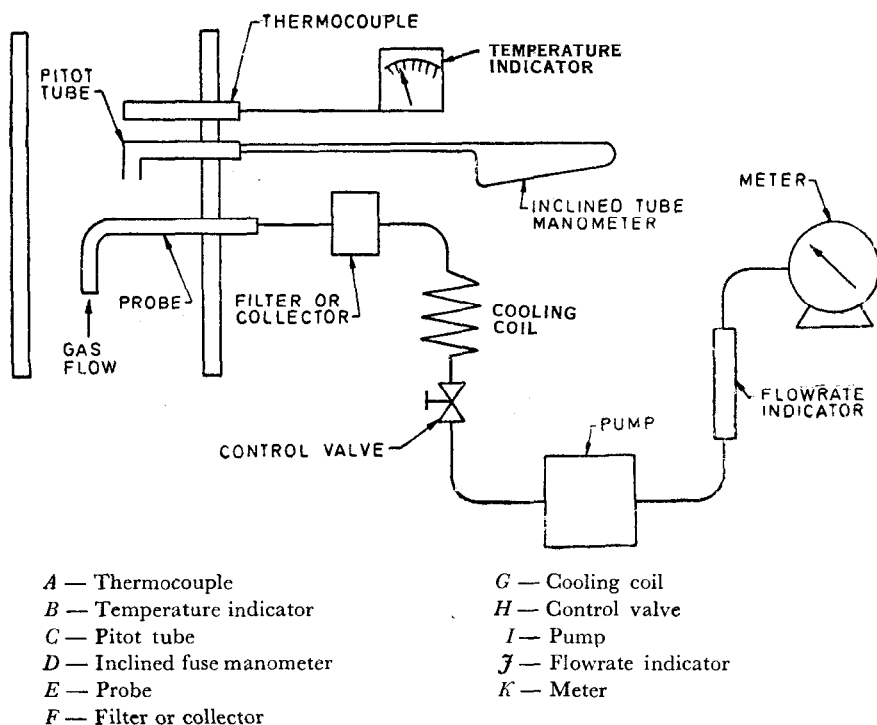


FIG. 11 APPARATUS FOR ISOKINETIC GAS SAMPLING

**3.13.1 Procedure** — Move the probe ( nozzle ) to face the up stream of the gas sample. Commence collecting sample on filter, adjusting the gas flow rate to the required value. Continue sampling for appropriate period of time to collect sufficient solids and then stop the gas flow. Rotate the probe through  $180^\circ$  angle, then withdraw it and transfer any dust retained in the probe and connecting tube into a labelled sample container. Remove the filter plus collected solids and transfer it into the sample container for subsequent examination. Read from the meter the volume of gas passed through the filter.